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Maternal mortality in Brazil from 2001 to 2012: time trends and regional differences

Mortalidade materna no Brasil no período de 2001 a 2012: tendência temporal e diferenças regionais

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ABSTRACT: *Objective:* To assess time trends in maternal mortality in Brazil and its five geographical regions from 2001 to 2012, as well as to describe its main causes. *Methods:* This is a time series analysis, from data obtained in the Mortality Information System (SIM) and in the Live Births Information System (SINASC). Maternal mortality ratio (MMR) and causes of maternal death were described according to the categories of the Tenth Revision of the International Classification of Diseases, in the years 2001, 2006, and 2011. To estimate time trends, linear regression was used. *Results:* The highest MMR in Brazil was observed in 2009 (77.31 per 100,000 live births). A significant decreasing trend was observed in the Northeast and South regions and a significant increasing trend was found in the Midwest. There was an increase in deaths from other obstetric conditions and a decrease in deaths from edema, proteinuria and hypertensive disorders. *Conclusion:* Although there was a decreasing trend in the MMR in the Northeast and South regions, the high ratio observed in Brazil reveals the need to improve health care in prenatal, childbirth, and puerperium periods.

Keywords: Maternal mortality. Causes of death. Health Information Systems. Women's health. Prenatal care. Epidemiology.

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RESUMO: *Objetivo:* Avaliar a tendência de mortalidade materna no Brasil e nas cinco regiões brasileiras, de 2001 a 2012, e descrever suas principais causas. *Métodos:* Trata-se de uma série temporal, a partir de dados obtidos no Sistema de Informação sobre Mortalidade e no Sistema de Informação sobre Nascidos Vivos. A razão de mortalidade materna e as causas de morte materna foram descritas conforme as categorias da 10ª revisão da Classificação Internacional de Doenças, nos anos de 2001, 2006 e 2011. Para estimar a tendência temporal foi utilizada a regressão linear. *Resultados:* A razão de mortalidade materna mais elevada no Brasil foi no ano de 2009 (77,31 por 100 mil nascidos vivos). Foi observada tendência significativa de diminuição da razão de mortalidade materna para as regiões Nordeste e Sul e de aumento na região Centro-Oeste. Houve incremento nas mortes por outras afecções obstétricas e uma queda nas mortes por edema, proteinúria e transtornos hipertensivos. *Conclusão:* Embora tenham sido observadas tendências de diminuição da razão de mortalidade materna para o Nordeste e o Sul, as elevadas taxas observadas para o Brasil evidenciam a necessidade de melhoria à assistência pré-natal, ao parto e ao puerpério.

Palavras-chave: Mortalidade materna. Causas de morte. Sistemas de Informação em Saúde. Saúde da mulher. Cuidado pré-natal. Epidemiologia.

INTRODUCTION

According to the International Statistical Classification of Diseases and Related Health Problems (ICD-10) and the World Health Organization (WHO), maternal mortality is defined as:

The death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes.¹

After 1980, with the adoption of policies and health actions for women, maternal mortality started to gain prominence in the scenario of health policies in Brazil². Given its magnitude and challenges for its reduction, especially in countries with low and middle incomes, the United Nations (UN) in 2000, in the Millennium Declaration, approved the “millennium development goals” of which the fifth is “improve the health of women,” one of its components being the reduction of maternal mortality by three quarters until 2015³. In a study with data from approximately 180 countries between 1990 and 2013, Kassebaum et al. estimated that only 16 countries, of these only 7 being low- and middle-income countries, would reach the fifth “millennium development goal.”⁴ Victora et al. reported, in 2011, that Brazil possibly would not reach this reduction target of three quarters of maternal mortality rate in the period of 1990 to 2015². Also, in the recently published final report of the “Countdown to 2015,” it can be seen that Brazil has not reached that goal⁵.

In Brazil, maternal mortality rates are extremely high and have wide disparities between geographical regions⁶. Some estimates suggest a decline in the rates². However, over the

years, information on maternal mortality rates in the country have suffered from under-reporting of deaths and inadequate report of recorded causes of death⁷. In recent years, a series of government initiatives were carried out in order to improve the notification system⁸. Thus, studies of time trends in maternal mortality, which do not take into account these changes in the surveillance system, may have inaccurate results.

In order to improve the quality of information, Laurenti et al. and Luizaga et al. proposed correction factors to minimize the underreporting of maternal deaths. These factors are applied to the total of official maternal deaths, so that the estimated indicators are closer to actual values^{6,9}. Knowing the urgency of this subject in Brazil, the possibility of using these correction factors to obtain more accurate estimates of how maternal mortality rates have behaved over the last few years, as well as to know the regional differences and the main causes, is extremely important to the public health policies of the country and for the health services planning. Therefore, the objective of the study is to assess time trends in maternal mortality in Brazil and in its five geographical regions from 2001 to 2012, as well as to describe the main groups of maternal death causes.

METHODS

A time series study with secondary data analysis was carried out, covering the period of 2001 – 2012, from health information available in the database of DATASUS (Information Technology Department of the Brazilian Public Health Care System)¹⁰. For each year studied, the data were obtained in the Mortality Information System (SIM) and on the Information System on Live Births (SINASC), that carry out systematic records of data on mortality and survival by means of the Declaration of Deaths¹¹ and the Declaration of Liveborn Infants¹².

The maternal mortality rate was estimated from the definition recommended by the WHO¹, and corresponds to the Chapter XV of the ICD-10 — "Pregnancy, childbirth and puerperium" — and the other deaths considered maternal, but classified in other chapters. The number of deaths considered maternal was selected, according to place of residence (region), regardless of age. Maternal deaths from obstetric causes in the period between 42 days and less than a year after birth are considered late deaths (codes O96 and O97 of ICD-10) and were not addressed in this study.

The maternal mortality ratio (MMR) represents the obstetric risk associated with pregnancy and is defined by the ratio between the number of maternal deaths during the period of a year per 100,000 live births during the same period¹³. To calculate the MMR, births (obtained through SINASC) and maternal deaths (obtained through SIM) were used according to the Brazilian region of the mother's residence. The MMR was calculated for the country and according to the five Brazilian regions (North, Northeast, Southeast, South, and Midwest). The causes of maternal death were also described regarding Brazil and its regions, in the years 2001, 2006, and 2011, according to the categories of ICD-10, as follows:

1. (O00-O08) Pregnancy with abortive outcome;
2. (O10-O16) Edema, proteinuria, and hypertensive disorders in pregnancy, childbirth, and the puerperium;
3. (O30-O48) Maternal care related to the fetus and amniotic cavity and possible delivery problems;
4. (O60-O75) Complications of labor and delivery;
5. (O85-O92) Complications predominantly related to the puerperium; and
6. (O94, O95, O98, O99) Other obstetric conditions not elsewhere classified.

Maternal disorders predominantly related to pregnancy, HIV, behavioral syndromes associated with physiological disturbances, and physical factors as well as other endocrine glands disorders were grouped into a single category defined as “other causes.” In addition, the main causes of maternal death in the categories of ICD-10 that had higher levels of maternal mortality in the 3 years observed were described.

To calculate the mortality rates, adjustment factors to maternal deaths were used. In the period from 2001 to 2007, correction factors proposed by Laurenti et al.⁶ were used for the Brazilian regions and Brazil; thus, 1.08 – North; 1.76 – Northeast; 1.10 – Midwest; 1.35 – Southeast; 1.83 – South; and 1.40 – Brazil. For the period from 2008 to 2012, the factors updated by Luizaga et al.⁹ were applied. The factor of 0.93 was applied for the North region, 1.17 for Northeast, 1.47 for Midwest, 1.29 for Southeast, 1.1 for South, and 1.19 for Brazil. The use of factors throughout the period was established in accordance with those used by the Ministry of Health¹⁴.

The change in the MMR was calculated through the absolute and relative difference by comparing the year 2012 to 2001. To estimate the time trend in MMR, from 2001 to 2012, linear regression was used. All the analyses were based on public data available on the Internet, with unrestricted access data, and without identifying individuals. Data were analyzed using the software *Stata* version 12.0.

Due to the use of data of public domain, with unrestricted access, the analysis on ethics which is carried out by the system *Comitê de Ética em Pesquisa* / CONEP is dispensed by the *Comissão Nacional de Ética em Pesquisa* (CONEP) to conduct this study.

RESULTS

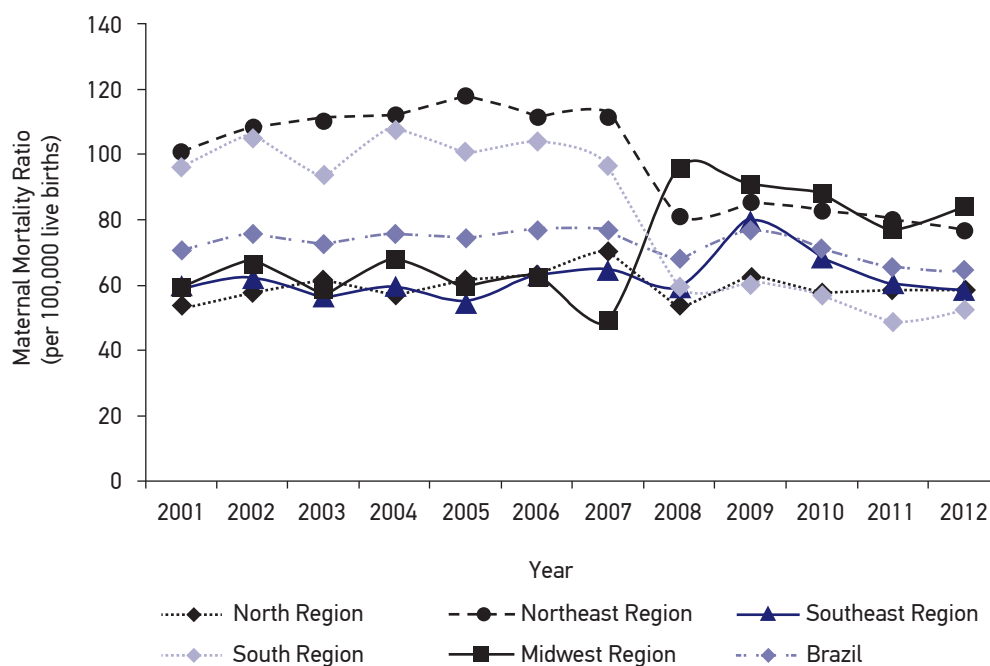
The MMR values from 2001 to 2012 in Brazil, and in its regions, are shown in Figure 1. The highest MMR in Brazil was found in 2009 (77 per 100,000 live births), and the lowest in 2012 (65 per 100,000 live births).

Among the regions of the country, from 2001 to 2007, the Northeast and South showed the highest MMR values. From 2008 to 2012, the highest values of MMR were found in the Midwest and Northeast. Within the study period, the lowest values of MMR for each year varied between regions. From 2009 to 2012, the South and the North regions had the

lowest values of MMR in the country. The highest MMR, among the five regions in the study period, was found in 2005 in the Northeast (118 per 100,000 live births), and the lowest in 2011 in the South (49 per 100,000 live births).

Analyzing the whole period from 2001 to 2012, no significant trend of increase or decrease in MMR in the North and Southeast regions and Brazil itself was found. However, a significant downward trend in the MMR in the study period for the Northeast and South regions was found, showing a reduction of 3 and 6 maternal deaths per 100,000 live births for each year, respectively. Besides, a significant increase of MMR trend was detected for the Midwest region in the study period, an increase of 3 maternal deaths per 100,000 live births every year.

The relative ($\Delta\%$) and absolute (Δ absolute) changes in MMR values throughout the study period can be observed in Figure 2. The Southern region was the one that presented the highest relative change (-45%), corresponding to a decrease of 44 deaths per 100,000 live births. On the other hand, the Midwest region was the one that presented the highest percentage increase of MMR in 2012 compared to the year 2001 (42%), which corresponded to an increase of 25 deaths per 100,000 live births. Brazil presented a percentage reduction in MMR of 9% in 2012 compared to the year 2001, corresponding to a decrease of 6 deaths per 100,000 live births.



*linear trend: North: $p = 0.714$; Northeast: $p = 0.003$; Southeast: $p = 0.297$; South: $p < 0.001$; Midwest: $p = 0.020$; Brazil: $p = 0.092$.

Figure 1. Maternal mortality ratio in Brazil and in the regions in the period from 2001 to 2012.

Figure 3 presents the proportional mortality for the main groups of maternal mortality causes by regions of Brazil, categorized by codes of Chapter XV of ICD-10, in 2001, 2006, and 2011. Edema, proteinuria, and hypertensive disorders (O10-O16) appear to be the main causes of maternal death in the North in 2001 (24%), 2006 (30%), and 2011 (27%), in the Northeast and Southeast regions in the years 2001 (24% and 26%, respectively) and 2006 (30% and 25%, respectively), and in the Midwest region in 2001 (28%) and 2011 (32%). Other obstetric conditions (O94-O99) were the leading cause of maternal death in the South in the 3 years analyzed (24, 32, 38%), in the Northeast and Southeast in 2011 (26 and 32 %, respectively) and in the Midwest region in 2006 (34%).

Moreover, an increase in those 3 years in maternal deaths due to other obstetric conditions (O94, O95, O98, O99) in all regions, except the Midwest, was observed. It was also detected a decrease in maternal deaths linked to maternal care related to the fetus and amniotic cavity and possible delivery problems. In Brazil, there was an increase of maternal deaths for other obstetric conditions (O94, O95, O98, O99) during the study period, as well as a decrease in maternal deaths by edema, proteinuria, and hypertensive disorders (O10-O16) and complications related predominantly with the puerperium (O85-O92).

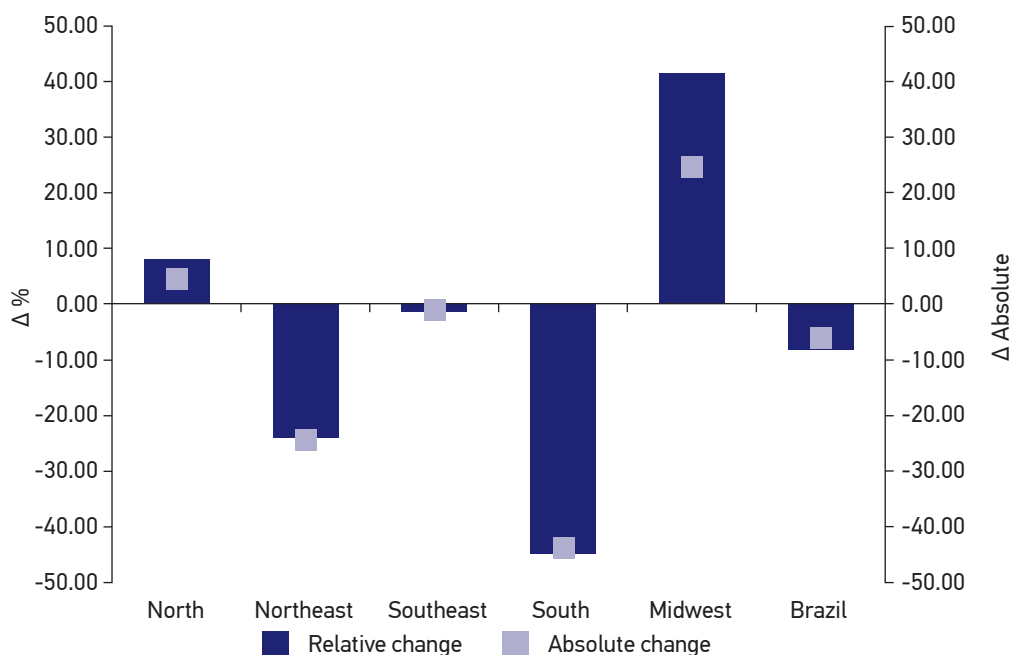
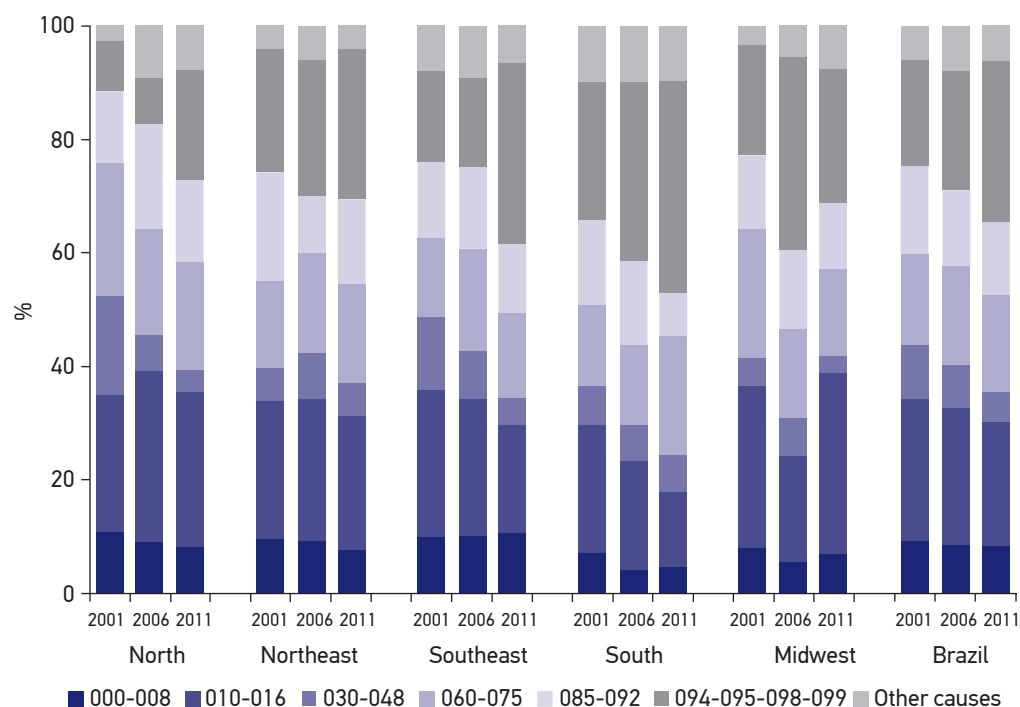


Figure 2. Relative and absolute change of MMR in 2012 compared to 2001 in the Brazilian regions and in Brazil.

Analyzing the leading cause of maternal mortality classified within the ICD-10 groups with the highest number of deaths in 2001, 2006, and 2011, it was found that eclampsia (O15) was the leading cause of maternal mortality in the North in the 3 years studied, in the Northeast and Southeast in 2001 and 2006, and in the Midwest in 2001. Other diseases of the mother complicating the pregnancy, childbirth, and the puerperium (O99) were the leading cause of maternal mortality in the South region during the study period, in 2006 for the Midwest region, and 2011 for the Northeast and Southeast regions. Gestational hypertension with significant proteinuria (O14) was the main cause of maternal mortality in the Midwest in 2011. For Brazil, it was found that eclampsia (O15) was the major cause in 2001 and 2006; and other diseases of the mother (O99) in 2011.



(000-008) Pregnancy with abortive outcome;
 (010-016) Edema, proteinuria and hypertensive disorders in pregnancy, childbirth and the puerperium;
 (030-048) Maternal care related to the fetus and amniotic cavity and possible delivery problems.
 (060-075) Complications of labor and delivery;
 (085-092) Complications predominantly related to the puerperium; and
 (094, 095, 098, 099) Other obstetric conditions not elsewhere classified.
 (Other causes) Other maternal disorders predominantly related to pregnancy, HIV, behavioral syndromes associated with physiological disturbances and physical factors and disorders of other endocrine glands.

Figure 3. Main groups of causes of death in the regions of Brazil, by codes of Chapter XV of ICD-10, in 2001, 2006 and 2011.

DISCUSSION

According to the results of the study, between 2001 and 2012, there was an increase in the MMR in the Midwest region and a reduction in the Northeast and South. In the other regions and in Brazil, the values of MMR were stable. With regard to the main causes of maternal death, for all regions stood out those of the edema, proteinuria and hypertensive disorders group, and other obstetric conditions group.

The maternal mortality rate is an important indicator of health and it reflects the quality of attention to women's health. The evaluation and monitoring of this indicator is very important because high MMR values are associated with inadequate provision of health services to this group, from family planning and prenatal care to the puerperium¹⁵. However, the time trends assessment in maternal mortality is difficult and complex, given the absence and/or underreporting of data in some locations, as well as the reliability of the information⁶. Furthermore, the use of secondary data implies some limitations. In addition to regional differences and persistent underreporting¹⁶, the information is not collected to assess the objective of the study in question, meaning that the researcher has little control over the data¹⁷.

Nevertheless, this scenario has been changing in recent years. As a result of political movements to increase the visibility of maternal deaths, a series of actions were carried out by providing improvements in the system of registration and notification of deaths, including the compulsory investigation of deaths of women in reproductive age². Moreover, in order to improve the quality of information and minimize underreporting, correction factors^{6,9} have been proposed and used in the present study. These advances, though positive, implicate a cautious interpretation of time trend analysis and regional maternal mortality indicator differences.

At the global level, two major systematic reviews on maternal mortality in the world and its main causes were published. The first gathered data from 115 countries and has accounted 60,799 deaths between the years 2002 and 2009, with significant differences between the regions of the world¹⁸. In Latin America, for example, it was observed that the greater proportion of maternal deaths occurred due to bleeding (23.1%; 95%CI 19.7 – 27.8), followed by hypertension. The second review showed maternal mortality trajectories between 1990 and 2013, detailing the data for countries within each region⁴. This study demonstrated that there are still high rates in low- and middle-income countries, although the absolute number of deaths worldwide has decreased from 376,034 (95%CI 343,483 – 407,574) in 1990 to 292,982 (95%CI 261,017 – 327,792) in 2013.

In Brazil, published data are discrepant with respect to trends in MMR. In a document on maternal mortality trends from 1990 to 2010, WHO, UNICEF (United Nations Children's Fund), and The World Bank Estimates indicate a decline in MMR in Brazil, from 120 deaths in 1990 to 56 deaths in 2010, per 100,000 live births, with a decrease of 3.5 deaths every year¹. While the Brazilian Ministry of Health, based on official statistics, reports stable values of MMR since 1996, with a MMR around 50 deaths per 100,000 live births², corroborating the results found in this study.

In this study, the Northeast and Midwest regions showed the highest values of MMR. The striking socioeconomic differences among Brazilian regions may explain part of the differences found in the MMR. The Northeast being one of the regions with the highest

rate of underreporting of MMR¹⁵, having a higher percentage of illiteracy, the largest population in vulnerability for economic and social deprivation¹⁹, in addition to the difficulties in the access and use of health services²⁰, it is expected that the MMR could still be higher than that obtained by means of the data used in this study.

A reduction by nearly half of the 2012 rate (64,83 deaths per 100,000 live births) is necessary for Brazil to achieve the fifth “millennium development goal” that is, three-quarters reduction in maternal mortality from 1990 to 2015, corresponding to a rate of 35 maternal deaths for every 100,000 births. Unfortunately, the challenge of significantly reducing maternal mortality rates in the country remains.

Regarding the causes of maternal death, it is important to distinguish between the causes of direct obstetric death — that are the result of complications of pregnancy, childbirth, and the postpartum period due to interventions, the lack of or inadequate treatment, or the chain of events that can elapse during these — and the causes of indirect obstetric death²¹. The latter are the result of previously existing diseases or diseases developed during pregnancy, which are not direct obstetric causes, but that have their situation aggravated by gestation²¹. When analyzing the main cause within the group of classification of ICD-10 with higher proportional maternal mortality rate in the regions and in Brazil in the years 2001, 2006, and 2011, it was found that for Brazil and for the Northeast and Southeast regions, in the first two years, the main cause was by direct obstetric death, whereas in 2011 it changed to indirect obstetric death. However, in the North and Midwest in 2011 the main cause consisted of directly related events in pregnancy, childbirth, and postpartum. The interpretation of these data should be cautious; however, it is evident that the planning of public policies and health services in relation to maternal health must be specific to each region, considering the differences in the rates and causes of maternal mortality between them over the past years.

CONCLUSION

The maternal mortality rate must be a health priority in Brazil, in view of the high values of MMR found in all regions, especially in the Midwest, and the absence of significant reduction in the MMR in recent years, even after confirmation of its importance in establishing the “millennium development goals.” Furthermore, it is known that the majority of maternal deaths could be prevented if there was a good quality in health services, if they were comprehensive and interdisciplinary, ranging from family planning, prenatal care, delivery, to the postpartum period, as well as an awareness of mothers for the importance of medical assistance in these periods.

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